Experiments with various anæsthetics and narcotics show that these suspend the activities of nerve cells to such an extent that in deep anæsthesia, electrical stimulation produces no rise in brain temperature. Elective action of stimulating drugs on the different tissues is well shown by the injection of cocaine, ten centigrams of the hydrochlorate causing a rise in brain temperature of 0°.36 C., no change being observed in either muscles or rectum. The effect of cocaine upon the brain is rendered more conspicuous by combination with curare. In a deeply curarized dog, the temperature of the whole body was observed to rise 4°, from 37° to 41° C., within a half hour after the injection of the cocaine. That the effect upon the brain caused this rise is shown by the brain temperature being 0°.2 C. above that of the rectum during the time. The experiments are of special interest as indicating active chemical changes within the brain.

The Changes in the Optic Tracts and Chiasma in a Case of Unilateral Optic Atrophy. WILLIAMSON, R. T. AND M. R. C. P. (LOND.) Brain, Part LVIII. p. 230. 1892.

Hannah T., age 56. Complete loss of vision R. eye; atrophy of R. optic disc. Left eye and L. field of vision, normal. Sudden onset of blindness in R. eye after an attack of rheumatism, four years previous to death. Findings agree in the main with those, for similar cases, recorded by Purtschner and v. Gudden. The optic nerve of right side was much shrunken, and contained almost no healthy fibers. Left optic nerve was normal. In the chiasma, the degenerated optic nerve fibers were found to pass to the inferior surface of the opposite side. In the optic tracts, an area of degeneration could be plainly seen occupying the central area of the right side (uncrossed fibers). The left optic tract was much shrunken, and showed degeneration chiefly in the inner half of the inferior surface. Indications of degeneration extended also to the outer half of the inferior surface and to the outer surface. Hence uncrossed fibers occupy the central portion of the optic tract; while crossed fibers, with slight modification of Purtschner's statement, lie along the periphery of the tract. Microscopical examination was made by Weigert's method. A series of eleven well selected drawings add great clearness to the description.

I.—Il cervelletto; nuovi studi di fisiologia normale e pathologica. LUIGI, LUCIANI. Firenze, 1891.

II.—Sull' origine e decorso dei peduncoli cerebelleri e sui loro rapporti cogli altri centri nervosi. MARCHI, VITT. Firenze, 1891.

Of the above papers, the first deals with the physiology, the second with the anatomical connections of the cerebellum, as shown by degenerations resulting from partial or entire extirpation.

Dogs and monkeys were employed for the experiments. The cerebellum was removed, wholly or in part, under narcosis produced in dogs by hypodermic injection of morphia and chloral (morphia 2.5 centigram, chloral 1 gram), and in monkeys by morphia and chloroform.

The principal operations studied were: *Extirpation of the middle lobe of the cerebellum; extirpation of the whole cerebellum; extirpation of one-half of the cerebellum.* This latter was done by dividing the vermis in the median plane by means of a Græf's knife.

Operations upon the cerebellum at best are difficult, great care being necessary to avoid excessive hemorrhage and the injury to

adjacent parts of the brain, and especially of the medulla. Hemorrhage was arrested by means of bits of sponge soaked in corrosive sublimate solution (1-1,000). The operations were eminently successful, as is attested by the fact that Luciani kept his animals months and even years after total extirpation of the cerebellum. In this way, he was able to distinguish between temporary and permanent effects.

For convenience, the results are classified under five categories: *1. Phenomena of irritation*, disturbances of innervation attending more or less closely upon the operation. *2. Phenomena of deficiency.* These are to be attributed to lack of the portion of the cerebellum, which has been removed, and form, perhaps, the chief feature of interest in the research. The following symptoms are noted as characteristic of cerebellar deficiency: Lack of voluntary power—*asthenia;* lack of muscular tone—*atonia;* and uncertainty of movement, tremor, oscillation—*astasia.* It is impossible to separate these clearly from the next group. *3. Phenomena of compensation;* classified as organic,—a gradual lessening of the phenomena of deficiency and functional,—abnormal movements directed to correct faulty movements occasioned by deficiency. *4. Phenomena of degeneration;* in other parts of the nervous system following cerebellar extirpation. *5. Trophic phenomena;* it is claimed indirectly, that the cerebellum exerts an influence upon the nutrition of the tissues.

I.—Effect of division in the median plane. In the case of three animals, the cerebellum was divided in the median plane. One dog lived twenty-two months after the operation, and was carefully studied. Some difficulty in co-ordination was noted at first, and, as a phenomenon of deficiency, lack of energy in the performance of voluntary acts and diminution of muscular tone were the more lasting results. Tracings of the dog's footprints were taken by dipping the feet in different colored inks; and these showed that *compensation* became so perfect that it was difficult to discern anything abnormal in the gait. The general disturbances are, however, sufficiently marked to lead the author to conclude that the cerebellum is physiologically a unit as well as anatomically, and not divisible bilaterally without interfering with its function.

II.—Effects of removing the middle lobe. Four dogs and two monkeys were operated on. The case of one monkey may suffice to illustrate the other experiments of this class. Immediately after the operation, there was noted tonic contraction of neck muscles and tonic flexion of upper and lower limbs. By the next day, the animal was able to extend a weak tremulous hand for fruit, but if placed on the floor, could not keep its feet, and tended to fall from right to left. Second day after operation, the monkey lay with limbs flexed, and neck and trunk in continual oscillation. After about ten days, it had regained power to walk slowly and with fair co-ordination.

By raising a monkey from the floor by means of a belt around the waist and a pulley, allowing it to hold on with its hands to a dynamometer ring fastened to the floor, a method was devised of testing voluntary power or muscular strength. In this way, a healthy monkey would pull 8 to 10 kilos. After removal of vermis, he was able to register only 3 kilos. In a month, however, he was able to pull 5.5 kilos. In two months, recovery had become so complete that it was distinguished from the healthy monkeys with difficulty. In a year, muscular power had risen to 9 kilos. The dogs gave similar results, except that instead of flexion, the limbs were extended.

III.—Effects of incomplete unilateral extirpation. (Extirpation of one lateral lobe.) This operation was performed upon dogs. The symptoms were in the main similar to those attending extirpation of the vermis, but differed in some points. The *irritative phenomena* consisted of curvation of the spine toward the wounded side, with tonic extension of the anterior limbs on the same side, and rotation of the body upon its longitudinal axis from the wounded toward the healthy side with strabismus in the same direction. *The phenomena of deficiency* were confined to the side of the lesion. *Compensation* took place gradually, so that the animals regained power to walk.

IV.—Effect of removal of one-half of the cerebellum. (Both dogs and monkeys.) Monkey, right half of cerebellum removed June 26, 1884. After operation, the head was bent to the right, and rotated toward the left, rotation about long axis of body from right to left.

June 27.—Still a tendency to rotate from right to left, which the animal tries to avoid by catching hold of something with the left hand. The head is held as before. Both limbs of the right (operated) side are held flexed. The right pupil is more contracted than the left, with strabismus of the left eye inward and upward, and nystagmus of both eyes.

June 28.—Pupils of more equal size, tendency to rotation less. In attempting to take food, there is great oscillation of right arm.

June 29.—The above phenomena present, but less marked. The right leg has relaxed; tonic flexion of right arm persists.

July 1.—Phenomena of irritation and deficiency decreasing steadily. The animal takes fruit with the left hand. It uses the limbs of the left side, while those of the right hang apparently inert.

Middle of July.—Begins to use right arm more freely. Strength of arms as registered by dynamometer, 3.5 kilos.

September.—Traction of arms, 8.2 kilos. Great improvement in walking, though it raises its feet high off the ground. Head is still inclined toward the right, and slight strabismus persists.

April, 1885.—Still timorous and suspicious. Head is inclined to the right. In walking, the body is bent toward the right, and progression is in consequence obliquely forward and to the right. Indecision of voluntary movements is noticeable. Food is invariably taken with the left hand. There is still slight strabismus, the right eye turning inward, the left outward and upward. Slight ptosis of the right upper lid is also noted.

The phenomena of irritation and deficiency are what would be expected. The fact of special interest is that compensation does not become perfect. One-half of the cerebellum cannot perform the functions of the other half; and the cerebral hemispheres, with one-half of the cerebellum present, are not able, at least in ten months' time, to render movements and position bilaterally symmetrical.

One lateral lobe was removed in case of dogs with the vermis destroyed, with results in the main like those just enumerated for *hemi-extirpation.*

IV.—Effects of complete extirpation of the whole cerebellum. Operation on both dogs and monkeys.

June 12, 1886.—Entire cerebellum removed from a monkey. After operation, tonic flexion of both arms, the right more than the left; was noted also slight convergent strabismus of both eyes. It is unable to maintain an upright position. In about an hour, the animal was able to crowd its back into the corner of its box, thereby holding itself upright, and to take a piece of fruit with its left hand.

June 13.—Still keeps its back in the corner of its box, and holds out both hands when offered food. Deprived of support, it falls in a lump, and is unable to raise itself up again.

June 14.—Condition similar to that of previous day. When unsupported, tends to rotate from right to left. It can climb up the side of its cage, but cannot remain there without support.

June 16.—Placed on the floor, unsupported, it takes a few steps forward and soon falls toward the right. In extending its hand for food, there is uncertainty of motion not previously noted.

July.—When sitting, head and trunk oscillate, and eating is accompanied with constant tremor of arms and trunk. It walks more slowly than a normal monkey, in a hesitating, oscillatory manner and zigzag course. Tendency to fall is less marked.

August.—Ataxic phenomena about the same as in July.

October, 1886—June, 1887.—No change; possibly a slight improvement in health.

July, 1887—January, 1888.—Ataxic phenomena persistent. It walks with limbs far apart and continual oscillations of head, and descends a ladder with great care and deliberation. During this month, the animal was killed. Autopsy showed that the entire cerebellum had been removed, except a small portion of each flocculus. The cerebrum appeared normal.

For complete extirpation of the cerebellum, the phenomena of irritation and deficiency resemble those found in extirpation of the middle lobe, except that they are more intense, last longer, and are more widely diffused.

VI.—Effects of extirpation of the cerebellum, combined with uni- or bilateral destruction of the sygmoid gyrus.

Compensatory movements were naturally supposed to arise from the motor regions of the cerebrum; and to test this point, the experiments upon the sygmoid gyrus were undertaken. Only dogs were employed.

One-half of the cerebellum was first removed, with results already described. The second operation consisted in partial destruction of both sygmoid gyri. This caused paresis of the extremities and defective sensibility. Finally, the remaining half of the cerebellum was removed. The phenomena of deficiency are now found to be persistent. Eleven months after the final operation, the dog was unable to walk without support. The experiments bear out the conclusion that deficiency of cerebellar innervation is compensated for by motor-sensory areas of the cerebral cortex, especially that part located in the region of the sygmoid gyrus.

A long discussion follows, explanatory of the above observed phenomena. Here the chief interest centres about the phenomena of deficiency, and these lead the author directly to his view of cerebellar function.

In the first place, Luciani's experiments show that cerebellar deficiency is manifested only in the sphere of voluntary movement. Sensation, instinct or intelligence is not affected. All the special senses, dermal and muscular sense, is intact. The instincts of self-preservation and reproduction are as active as ever. There is noticeable, however, in dogs, a certain listlessness and lack of energy. Aside from this, nothing of a psychic nature is to be correlated with the function of the cerebellum.

The cerebellum is, therefore, not an organ intercalated in the main paths of the cerebro-spinal system, but a tonic reinforcing centre placed alongside the main paths. It is more and more

highly developed as we ascend the vertebrate series, but in no form does complete muscular paralysis follow extirpation of the cerebellum. Further, the power to co-ordinate muscles remains. The disturbance of co-ordination so often noted in cases of cerebellar lesion, is not primarily lack of co-ordination, but lack of the tone, the energy to hold the muscles in a co-ordinated contraction. So that when the animal by careful attention has co-ordinated his muscles to maintain a certain position, if his attention is called away to something else, food, for example, he suddenly falls.

It remains to consider what Luciani calls the *trophic phenomena* associated with lesions of the cerebellum. Degenerations in the various parts of the brain and spinal cord plainly show that the cells of the cerebellum are the trophic centres for nerve fibers, which pass beyond its limits. These will be described later. Further, for the first few days after operation in some of the animals, polyuria, glycosuria and acetonuria were present. Marasmus, without apparent cause, alopecia, erythema and eczema, conjunctivitis and keratitis occurred in several cases. It is difficult to see in what way these prove any direct trophic action. There is little uniformity in their occurrence, and, moreover, they all heal readily upon the application of antiseptics. Fatty degeneration, with increase of muscle nuclei in the muscles of the limbs, is also noted as a trophic phenomenon.

A lengthy discussion of all the theories concerning the functions of the cerebellum follows, and the book closes with a chapter upon "first lines of a new doctrine." This has already been hinted at, and may be made plain with a few words in addition. The cerebellum is a nervous system by itself, added to the main system for the "sthenic," "tonic" and "static" reinforcement of motor impulses. Its action upon the body muscles is mainly direct, thereby differing from that of the cerebrum, whose action is crossed. Experiments do not show that the vermis is of any greater or any different functional value from the hemispheres. In fact, the organ is not a collection of centres or parts, which exert a special influence upon special muscles or groups of muscles, but it is a physiological unit. From it flows continuously and quietly a stream of nervous impulses to the whole muscular system. Removal of the cerebellum is thus shown in lack of muscular tone, and not in paralysis, partial or complete, which is apt to follow extirpation of portions of the cerebrum. The cerebellum is a reinforcing organ for the cerebro-spinal system.

The brains and spinal cords of the dogs and monkeys operated upon were given to Marchi for the purpose of working out the degenerations resulting from the partial or complete extirpations. Marchi employed Weigert's hæmatoxylin method, and a method of his own, which consists of hardening the specimens in Müller's fluid for a short time, and then further treating small pieces, 1 cm. cube with a solution of Müller's fluid and osmic acid (Müller's fluid, 2 parts; osmic acid, 1 per cent., 1 part), for 8 to 10 days longer. Degenerated portions by this process are stained black.

Most instructive are naturally the results following extirpation of half the cerebellum. These results for extirpation of right half are briefly as follows:

(a) In the superior peduncle and in region of the cerebrum, the method of Marchi gave evidence of degeneration in both peduncles, in the right more than in the left. There was much degeneration of the left red nucleus and a little of the right. There were also

evidences of the degeneration in the fillet, in the third pair of nerves, in the pyramidal tracts of the crura, in the posterior longitudinal bundle, and in the right optic tract.

(b) Complete sclerosis of the right middle peduncle was found, and the degeneration extended over the middle line, and involved the gray matter of the pons. Degenerated nerve fibers were also found in the right fifth nerve, in the fillet, in the posterior longitudinal bundle, and in a small bundle of fibers which lie behind and external to the superior peduncles.

(c) In the region of the inferior peduncles, the median portion of the peduncle and the external portion of the restiform body of the same side were degenerated. The other parts involved are certain of the striæ acousticæ and a portion of the external auditory nucleus, many fibers of the ascending root of the fifth nerve, the fillet, the interolivary layer, the posterior longitudinal bundle, some fibers of the hypoglossal nerve and of the pyramids. There also appeared to be some degeneration of the olivary body of the opposite side. The above degenerations were shown by Marchi's method. Wiegert's method did not give quite so diffuse showings.

(d) In the spinal cord degeneration was demonstrated by Marchi in the antero-lateral region of the same side with the extirpation, the affected fibers lying in part in the anterior portion of the direct cerebellar tract, and in part in the anterior pyramidal tract.

Due to extirpation of the vermis, Marchi demonstrates slight degeneration of the superior peduncles, although in the fillet, the posterior longitudinal bundle, the roots of the third nerve and the optic tracts, degeneration was considerable. This would indicate that the superior peduncles arise mainly from the lateral lobes. In the middle peduncles, all transverse fibers were degenerated. The inferior peduncles showed degeneration only in the lateral part of the restiform body. Beside the above, degeneration was demonstrated among the fibers of the trapezoid body, and in the roots of the fifth, eighth and twelfth cranial nerves, and also in the antero-lateral columns of the spinal cord.

Marchi summarizes his results as follows:—

1. The decussation of the superior peduncles is not complete. A small bundle of its fibers goes to the optic thalamus of the same side, while the main part of the peduncle ends in the red nucleus of the opposite side.

2. The middle cerebellar peduncles are not simply commisures between the lateral hemispheres. Many of their fibers end in the gray matter among their pyramidal bundles of the same and of the opposite side.

3. The inferior peduncle sends a bundle of fibers to the olivary body of the opposite side. It probably consists of afferent and efferent fibers.

4. The posterior longitudinal bundles and the fillet arise from a common source in the vermis. They pass down with the middle peduncles, and become connected with the nuclei of the cranial nerves, the nuclei of the pons, the corpora quadrigemina, and probably with the corpus striatum. At the level of the olive, the posterior longitudinal bundles unite with the fillet and thus make a connection between the antero-lateral regions and the anterior horns of the spinal cord.

5. The cranial nerves are intimately connected with the cerebellum by means of the fillet and posterior longitudinal bundles.

6. The origin of the three peduncles is diffused over the cerebellum, but the middle lobe gives rise to most of the fibers of the middle

peduncles and the nucleus dentatus, to the greater part of the fibers of the superior peduncles.

The above shows a more intricate connection of the cerebellum with other parts of the nervous system than has hitherto been demonstrated.

Sezione mediana antero-posterioe del verme del cervelletto. GALLERANI, G., AND BORGHERINI, A. Revista Sperimentale di Freniatria e di Med. Legale, Vol. XVIII. p. 369-388. 1892.

The authors state at the outset that their work was compiled before Luciani's book, Il Cervelletto, appeared, and that they will not take this occasion to discuss it. The work is further a continuation of experiments reported in the same journal in 1888. They bring forward but two experiments, both upon dogs, in the first of which the median division of the vermis was partial, extending about two-thirds its depth; the second, it was complete.

The first dog, one day after the operation, was unable to stand upon his feet. On the second day, he made weak attempts at walking. The trunk oscillated. On the fourth day, walking was still performed with legs half flexed. The gait was plainly ataxic, and ataxy of head and neck was seen when the animal tried to take food into his mouth. This condition of things is still present upon the ninth day. Observations upon the thirty-third day show that there is still ataxy, and lack of power to co-ordinate the muscles properly. This is seen especially when the animal begins a certain action. Once started, he can go on fairly well. He can run well, but in a slow walk his course is zigzag. All symptoms have about disappeared by the ninety-fifth day, when the dog is killed. Autopsy shows that the incision extended through about two-thirds of the depth of the vermis, and was healed with connective tissue.

In the case of the second dog, the phenomena are more marked and persistent. Upon the 142d day, the erect posture was maintained with oscillation of the trunk and with legs wide apart. Voluntary acts are done with slowness and attention, and although considerable improvement has been made in this respect, they are still ataxic. At this time, the animal was killed, and it was found that the division of the vermis was complete and remained so, the wound having become filled with connective tissue.

The authors consume three pages with their conclusions from these two experiments. Their aim in this seems to be to refute the idea of Schiff to the effect that the asymmetry of cerebellar lesions is of special importance in determining the amount of disturbance, and to contradict everything possible in Luciani's book. They further insist upon the correctness in the main of the old view, viz., that the cerebellum stands in close relation to the co-ordination of voluntary movements, both such as are directly voluntary and such as have become automatic by long use. The action of the cerebellum, they would explain, as Wundt does, as a kind of complicated reflex, which is composed on the one side of all the centripetal impulses from the skin, muscles, and organs of special sense, and upon the other side, of all the motor impulses which keep the body in equilibrium or render movement orderly. A lesion of the cerebellum will create a disturbance of co-ordination, not from the fact that it is asymmetrical, which has no influence in itself, but in proportion as it severs connection in the cerebellum with the different parts of its own mass, and especially as it interferes with the normal connections of the cerebellum with the other parts of the nervous system. The vermis connects the lateral hemispheres,